

## Appendix F – Hydrogen Quality

The hydrogen fuel quality guideline shown in Table F.1 below is based on the Society of Automotive Engineers' (SAE) specification in *SAE-2719 - Information Report on the Development of a Hydrogen Quality Guideline for Fuel Cell Vehicles*. This specification is based on a consensus between SAE and the International Standards Organization (ISO) related to the final draft hydrogen quality specification, *ISO/FDTS 14687-2*, which is currently in the ratification process. The primary purpose of this specification is to ensure acceptable fuel cell performance and durability in current demonstration vehicles. It does not take into account the economic impact of producing hydrogen of this quality. The limits in the table below are upper limits except for the hydrogen fuel index, which is a lower limit. Economic analysis of hydrogen production, delivery, and storage technologies; fuel quality R&D, fuel cell testing, and operational data from fuel cell vehicles; or improvements in the impurity tolerance of fuel cells, may lead to revisions of these limits. Hydrogen Program R&D planning will address hydrogen quality issues as they relate to cost and performance goals for each technology area – production, delivery, storage, fuel cells, safety, codes and standards. Those issues and R&D activities specific to each of these areas will be included in those sections of the RD&D Plan.

Table F.1. Hydrogen Fuel Quality Guideline			
Constituent	Units	Chemical Formula	Limit
Hydrogen fuel index	vol% *	H <sub>2</sub>	≥99.99%
<b>Non-hydrogen constituents</b>			
Total Non-Particulates	μmol/mol		100
Water <sup>a</sup>	μmol/mol	H <sub>2</sub> O	5
Total hydrocarbons <sup>b</sup> (C <sub>1</sub> basis)	μmol/mol		2
Oxygen	μmol/mol	O <sub>2</sub>	5
Helium, Nitrogen, Argon	μmol/mol	He, N <sub>2</sub> , Ar	100
Carbon dioxide <sup>c</sup>	μmol/mol	CO <sub>2</sub>	1
Carbon monoxide	μmol/mol	CO	0.2
Total sulfur <sup>d</sup>	μmol/mol		0.004
Formaldehyde	μmol/mol	HCHO	0.01
Formic acid	μmol/mol	HCOOH	0.2
Ammonia	μmol/mol	NH <sub>3</sub>	0.1
Total halogenates <sup>e</sup>	μmol/mol		0.05
Max. Particulate Size	μm		< 10
Particulate Concentration	μg/L H <sub>2</sub>		1

\* μmol/mol is also designated: ppm

<sup>a</sup> Due to water threshold level, the following constituents should not be found, however should be tested if there is a question on water content:

Sodium (Na<sup>+</sup>) @ < 0.05 μmole/mole H<sub>2</sub> or < 0.05 μg/liter

Potassium (K<sup>+</sup>) @ < 0.05 μmole/mole H<sub>2</sub> or < 0.08 μg/liter

or Potassium hydroxide (KOH) @ < 0.05 μmole/mole H<sub>2</sub> or < 0.12- μg/liter

<sup>b</sup> Includes, for example, ethylene, propylene, acetylene, benzene, phenol (paraffins, olefins, aromatic compounds, alcohols, aldehydes). Total hydrocarbons may exceed 2 μmole/mole due only to CH<sub>4</sub> if the total does not exceed 100 μmole/mole.

<sup>c</sup> The SAE document does not conform with ISO on CO<sub>2</sub>. SAE has agreed to harmonize that with ISO in the first revision cycle.

<sup>d</sup> Includes, for example, hydrogen sulfide (H<sub>2</sub>S), carbonyl sulfide (COS), carbon disulfide (CS<sub>2</sub>) and mercaptans

<sup>e</sup> Includes, for example, hydrogen bromide (HBr), hydrogen chloride (HCl), chlorine (Cl<sub>2</sub>) and organic halides (R-X)

